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SHIPPING TESTS WITH DELICIOUS APPLES FROM WENATCHEE, WASH. TO NEW YORK AND OTHER EASTERN MARKETS: A STUDY OF COMMODITY TEMPERATURES AND DESSERT QUALITY IN RELATION TO VARIOUS REFRIGERATION AND HEATER SERVICES. OCTOBER 25, 1945 to APRIL 17, 1946.

By

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Delicious apples usually move daily from the Pacific Northwest in carlot volume from September until April or May. At harvest non-precooled fruit is generally moved under standard refrigeration. Later in the season, shipments of precooled fruit may be made under one of several different types of refrigeration or heater services. Transit temperatures of 31 - 32° F. are ideal for Delicious apples, but with present refrigerator car equipment and means of protection against heat or cold, such commodity temperatures are difficult to attain commercially.

Object of the Work

Studies were undertaken to obtain information on transit temperatures prevailing in commercial shipments of Delicious apples, as customarily forwarded, and to evaluate their effect on the dessert quality of the fruit.

Extent of the Work

Four shipping tests of three cars each were made at different times during the marketing season. Test No. 1 was made with non-precooled fruit shipped under standard refrigeration in standard refrigerator cars and in fan cars. Test No. 2 was made during the season when the decision has to be made whether to ship under refrigeration or under heater service. In this test, shipments were made in both standard and Preco-equipped fan cars moving under initial ice, and in a standard car billed under Rule 515-C (no refrigeration, 1 charcoal heater lit at outside temperatures of 10° F.; 2nd heater lit at temperature of 5° below zero). Test No. 3 was made during sub-zero weather and included a standard car, a fan car with fans off moving under C.P.S. (W.F.E. thermostatically-controlled alcohol heaters), and a standard car moving under Rule 515-C using charcoal heaters. Test No. 4 was made at the close of the regular shipping season for Delicious apples when choice must be made between using initial ice or standard refrigeration. In this test, shipments were made in a standard and a fan car under Rule 247 (initial ice, one reicing) and a standard car moving under standard refrigeration.

Methods

The test fruit was grown at the Tree Fruit Experiment Station, Wenatchee, Washington, being a part of 500 boxes of loose fruit placed in commercial storage at 34° to 40° F. on October 4, 1945, after a delay of 1-1/2 days in the orchard. The entire lot was held in storage for 11 days and then commercially washed (sodium silicate 76 lbs. per 100 gal. at 110° and hydrochloric acid 1% at 105°), sorted, and graded. One hundred and twenty boxes of fruit in sizes 100 to 125 were selected from the original 500 and thoroughly composited and packed in standard wooden apple boxes. This fruit was then held continuously at 31° until used in the shipping tests.

Each car in every shipment carried two boxes of test fruit with a Ryan recording thermometer buried in the center of each package. The test lots were placed at the bottom bunker and top doorway centerline in all cars except in Test No. 3, in which the experimental fruit was carried in the top quarterlength, centerline and bottom doorway, north side positions. A Ryan recording thermometer was fastened securely to the understructure of one car in each test shipment to record the outside temperature during transit.

Upon unloading at destination all test boxes were removed to the Government laboratories at New York where the test fruit was examined for condition, firmness, and dessert quality immediately upon arrival, and again after ripening at room temperature for an additional 4 days.

Firmness of the fruit was measured with a Ballauf pressure tester using a 7/16 inch plunger on the pared surface of 3 sides of 10 representative apples.

Dessert quality was determined by 4 qualified judges working independently to evaluate the texture and flavor of 20 fruits in each lot according to the following score card:

Flavor	Numerical Rating
Full (typical aromatic Delicious taste)	40 - 50
Moderate (not quite full varietal flavor)	30 - 40
Slight (not neutral to taste, but lacking in flavor)	20 - 30
Stale (strong aftertaste, acetaldehydic)	0 - 20

Texture	
Firm	45 - 50
Crisp	35 - 45
Soft	25 - 35
Mealy	15 - 25
Breakdown	0 - 15

Dessert Quality Rating (Texture and Flavor)	Numerical Rating
Excellent	90 - 100
Good	76 - 89
Fair	51 - 75
Poor	0 - 50

Results

Shipping Test No. 1

The cars in this test were loaded "solid" with 854 packed boxes of warm fruit obtained from a packing shed at Chelan Station, Washington; they moved to Wenatchee with vents closed where they were initially iced approximately 24 hours after loading. Data pertaining to temperatures in transit are shown in figure 1. Other data pertaining to the test are summarized in table 1. Commodity temperatures in W.F.E. 66454 with "fans on" were quite similar at the top doorway and bottom bunker positions during the entire period in transit. Fruit at both positions was cooled gradually to 35° F. at destination. Temperatures in this car were lower than in either of the two companion cars. The fan car operated with "fans off" had a spread of approximately 9 degrees in the commodity temperatures in different parts of the load. The average of all top and bottom temperatures in the different cars during transit shows that the most cooling was accomplished by operation of the fans.

Owing to the failure of one of the instruments, a detailed comparison cannot be made of the commodity temperatures in the standard car and the fan-equipped car run with fans not operating. A comparison of average commodity temperature at the top doorway position in both cars indicates that refrigeration may have been somewhat impeded by the fan assembly beneath the floor racks at the bottom bunker opening.

The data in table 1 show that fruit placed at the bottom bunker position in all cars was generally firmer and of better dessert quality than that carried at the top doorway. All lots of fruit had best dessert quality at the time of arrival or during the 4 days of ripening at 70° F. By the 5th day some of the test fruit had become too soft. In view of the fact that the average variation in the 3 cars was only 9.2° (46.9° - 37.7°), and since the fruit was shipped so soon after harvest, it is not probable that dessert quality at destination would be influenced by the type of car or its operation during transit, especially since all 3 were under standard refrigeration for this relatively short time.

Shipping Test No. 2

Solid loads of 854 boxes of precooled fruit were shipped in a standard car and a fan car under initial ice, and in a standard car moving under modified heater service (Rule 515-C).

Figure 2 shows that outside temperatures during the first 4 days increased from an average of about 25° F. to approximately 31°. Colder weather encountered during the next 3 days brought minimum temperatures of 10°, 14°, and 3° respectively. In the last half of the transit period, mild weather was encountered with outside minimum temperatures above 30° and some maximums above 50°. Under Rule 515 paragraph C, heaters were not lighted in W.F.E. 38222.

It is apparent that the temperature of the fruit in the bottom layer in W.F.E. 38222 (without ice) did not decrease any more during the cold period (4th to 8th day) than did that in the comparable car shipped under initial ice.

There was no change in the commodity temperature of the bottom layer fruit in the fan car as it moved through the cold period under initial ice. The cold outside air temperatures affected only the top layer commodity temperatures which dropped from 37° to 35° F.

The temperature of the bottom layer fruit in the standard car without ice (W. F. E. 38222) increased from 34° to 44° F. during the last 8 days of transit. As the average outside air temperature during this period was 38.4°, the heat of respiration of the fruit probably had considerable effect in raising the temperature of the load to 44° or higher. The average commodity temperature at the bottom bunker position in this car was 36.2° compared with 33.3° in the comparable iced car and 35.3° at both the top and bottom positions in the iced fan car.

The use of fans with initial ice accomplished 3 things: (1) it kept the bottom layer temperatures at least 3° F. higher than in cars without fans during 4 days when outside air temperatures dropped to 3° above zero, thereby showing that the fans afford good protection against freezing; (2) it resulted in top layer temperatures that averaged 4.5° lower than in the standard car with initial ice; and (3) it resulted in uniform commodity temperatures in all layers of fruit as against a differential of 6.5° in the companion car without fans.

The temperatures shown in figure 2 indicate that shipping precooled apples in fan cars with "fans on" under initial ice can be recommended for late fall.

Data relative to the condition and dessert quality of the experimental fruit used in shipping test No. 2 are summarized in table 1. The apples having the lowest temperatures in transit generally were the firmest and of the highest dessert quality both at time of arrival and after being held for 4 days at 70° F. The uniformity in condition and quality of the fruit in the top and bottom layers in the fan car, in comparison with that at similar positions in the other cars shows the influence of the uniform temperatures brought about by use of the

fans. All lots of fruit retained good dessert quality for 5 days, one day longer than for comparable lots shipped 2 weeks earlier in cars under standard refrigeration but loaded with non-precooled fruit.

Shipping Test No. 3

Solid loads of 854 boxes of Delicious apples were shipped in standard cars F.G.E. 50273 and F.G.E. 50354, and a fan car, B.R.E. 74562. The type of heater service for each car is shown in table 1. F.G.E. 50354 was changed to C.P.S. at Havre, Mont. at 2:30 a.m. December 22 (between 3rd and 4th day, figure 3) when the reported outside temperature was 0° F. The fan car, B.R.E. 74562, was found to have been diverted in error at Havre, Mont. to Houston, Texas. Outside air temperatures shown in figure 3 apply in their entirety to the Houston car and to the New York cars only as far as Havre, Montana. From the records it appears that these latter cars were in heater territory from the second to the eighth days (figure 3). Heaters were removed from these cars at Lindale Junction (Minneapolis) and from the Houston car at Lincoln, Neb. where the latter was ordered under initial ice.

Commodity temperatures in the cars in test 3 are shown in figure 3. As the record in the top layer of F.G.E. 50273 is not complete, the average fruit temperature at the door, quarter, and bunker positions in the top and bottom layers, taken when the cars were unloaded were as follows:

	Top layer	Bottom layer
F.G.E. 50354 (charcoal heater)	44° F.	38°
F.G.E. 50273 (alcohol heater)	38	34

It is apparent in figure 3 that the charcoal heater raised the temperature of the fruit at the top quarterlength much faster than did the alcohol heater. After the car had passed through heater territory commodity temperatures in the bottom layer in the charcoal-heated car continued to increase markedly as a result of the residual heat in the load.

With regard to possible interference with air movement resulting from the presence of nonoperating fans, a comparison of commodity temperatures can be made only during the first 4 days in transit (B.R.E. 74562 and F.G.E. 50273 in figure 3). During this interval, fruit temperatures at the top quarterlength rose more rapidly in the fan car than in the standard car, but bottom layer temperatures also were higher in the former. The data in figure 3 are not sufficient to prove that the presence of fans that were not operating will impede the circulation of air during heater service. They do show, however, that it is possible to obtain top layer commodity temperatures of 50° F. or above with either thermo-alcohol or standard charcoal heaters.

The test boxes of fruit in the fan car diverted to Houston were not recovered. For that reason, only test lots in standard cars with thermo-alcohol and charcoal heaters were examined in New York. As shown in table 1, the greatest contrast in firmness and dessert quality was found in the top and bottom layers in the car with charcoal heaters. The fruit in the bottom layers of both cars was superior to that in the top layers. Good dessert quality was maintained for only 3 to 4 days after arrival. None of the fruit was of as good quality as that shipped under initial ice one month earlier.

Shipping Test No. 4

Transit refrigeration under Rule 247 requires initial icing to capacity at the point of origin with one reicing en route (as ordered by the shipper). In test No. 4, loads of 854 packed boxes of apples out of cold storage were shipped in a standard car and a fan car under Rule 247 and in a standard car under standard refrigeration. A comparison of the commodity temperatures in the three cars is shown in figure 4 and table 1.

Maximum and minimum outside air temperatures for the first 7 days were between 69° and 31° F. and between 72° and 42° for the remainder of the trip. F.G.E. 38150 (standard refrigeration) arrived in New York with ice bunkers full; F.G.E. 51310 when unloaded in Philadelphia had its bunkers about three-fourthsfull; and B.R.E. 74641 (fan) also unloaded in Philadelphia had ice bunkers approximately one-half full.

A comparison of commodity temperatures in these 3 cars shows that initial ice and one reicing in a fan car was more satisfactory than standard refrigeration in a standard car. Fruit temperatures rose markedly in both standard cars during the latter portion of the trip. Top layer temperatures were considerably higher in the car moving under Rule 247 than in its companion car shipped under standard refrigeration.

Upon arrival, the test fruit was generally firmest at the bottom bunker position. However, after holding at 70° F. for 4 days, it was not possible to correlate either firmness or dessert quality with transit conditions. Data in table 1 show that all of the test fruit scored lower upon arrival than in any of the previous shipments. At this late date in the shipping season the test lots held in good condition was limited for less than 3 days' at 70°. All lots lost their good Delicious quality by the close of the third day, which means that the retailer would have but little time to dispose of the fruit before it became soft and mealy. The consumer would be almost certain to receive fruit of poor quality, because as shown in table 1, after holding for 4 days fruit at 70° rated very low in dessert quality (according to the score card, it would be classified as "poor".)

It is not surprising that the dessert quality of this test fruit could not be correlated with its transit history, since differences in the average fruit temperatures in the 3 cars were not great (34° - 39° F.) Furthermore, as has been shown in (H. T. & S. Report 167-A), if the potential storage life and dessert quality of Delicious apples has been largely lost before shipment, high transit temperatures are much less important than with fruit which has excellent quality at time of shipment.

Table 1. Outline and Summary of Delicious Apple Shipping Tests. Wenatchee - Eastern Sea...

Date and Test No.	Car No.	Type of Car	Refrigeration or Heater Service	Destination	Position 4/	Fruit Temp. in Transit 1/ Start °F.	Mid °F.	Ave. °F.	2/	3/		
Oct. 25 Nov. 7 (1)	F.G.E. 38104	Std	Std. Refrig.	Boston	T.D.	45	41	42.2	12.7	9.9	63	58
					B.B.	-	-	-	13.3	10.6	70	74
	F.F.E. 66540	Fan	Std. Refrig.- Fans off	N.Y.	T.D.	51	42	46.9	11.3	9.8	71	54
					B.B.	46	34	37.7	13.2	10.8	63	60
	F.F.E. 66454	Fan	Std. Refrig.- Fans on	N.Y.	T.D.	52	34	41.8	11.8	10.6	72	60
					B.B.	52	35	40.0	13.7	1 .7	1	1
Nov. 8-22 (2)	F.F.E. 38218	Std	Initial Ice	N.Y.	T.D.	40	41	39.8	12.9	11.2	71	
					B.B.	34	34	33.3	14.1	12.4	63	
	F.F.E. 66532	Fan	Initial Ice- Fans on	N.Y.	T.D.	35	37	35.3	14.7	12.6	71	
					B.B.	33	36	33.3	14.2	11.9	64	
	F.F.E. 38222	Std	Rule 515-C Charcoal heater	N.Y.	T.D.	-	-	-	13.8	12.1	68	
					B.B.	33	44	36.2	14.5	12.7	80	
Dec. 18 Jan. 3 (3)	F.G.E. 50273	Std	C.P.S. Alcohol heaters	N. Y.	T.Q.	33	40	36.0	12.3	11.5		
					B.D.	31	33	31.4	12.7	11.5	72	
	F.G.E. 50334	Std	Rule 515-C Charcoal heater	N.Y.	T.Q.	35	45	45.3	11.1	10.2		
					B.D.	33	37	34.5	13.1	12.2	74	
	B.R.E. 74562	Fan	C.P.S. Fans Off Alcohol heaters	Diverted to Houston,Tex.	T.Q.	-	-	-	-	-	-	-
					B.D.	-	-	-	-	-	-	-
April 5-17 (4)	B.R.E. 74641	Fan	Initial Ice - 1 reice-Fans on	Phila.	T.D.	34	37	34.8	11.0	10.0	56	
					B.B	33	36	34.1	12.5	11.5	74	
	F.G.E. 51310	Std	Initial Ice- 1 reice	Phila.	T.D.	35	43	39.0	11.5	10.	61	
					B.B.	34	36	35.1	12.4	10.8	74	
	F.G.E. 38150	Std	Std. Refrig.	N.Y.	T.D.	33	42	36.3	11.5	11.1	74	
					B.B.	32	37	34.0	12.5	10.8	67	

1/ Average of temperature at intervals of 24 hours during transit.
2/ Pounds pressure (U.S.D.A. pressure tester).
3/ Numerical value of texture and flavor as established by taste.
4/ Abbreviations: T.D., top doorway; B.B., bottom marker, T.Q., top quarterlength; B.D., b

Figure 1. Deliveries per leg. Cycle - [illegible] Trip 1. [illegible] cwt.

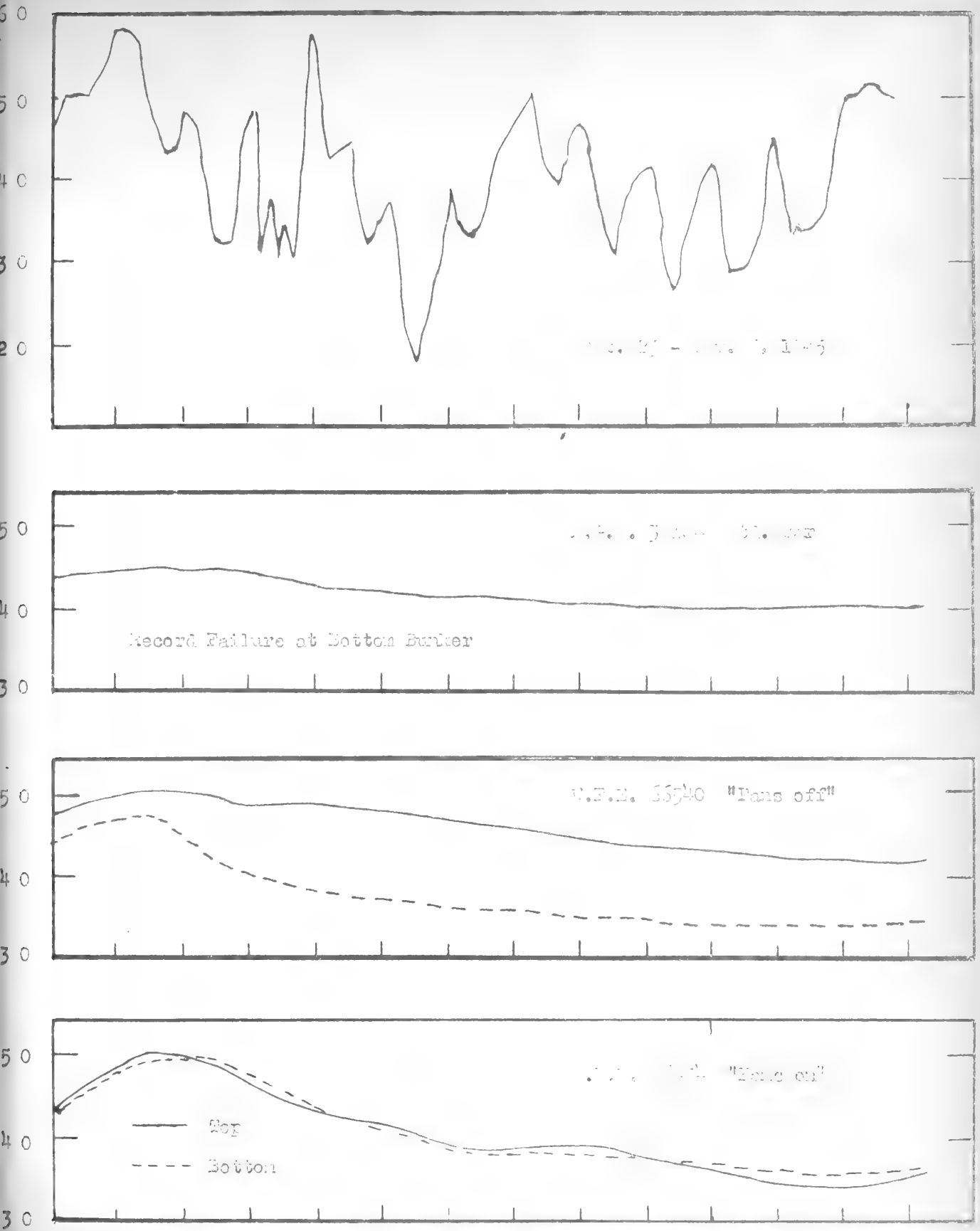

Figure 2. Delicious Apples. Chelan - N.Y. Test 2.

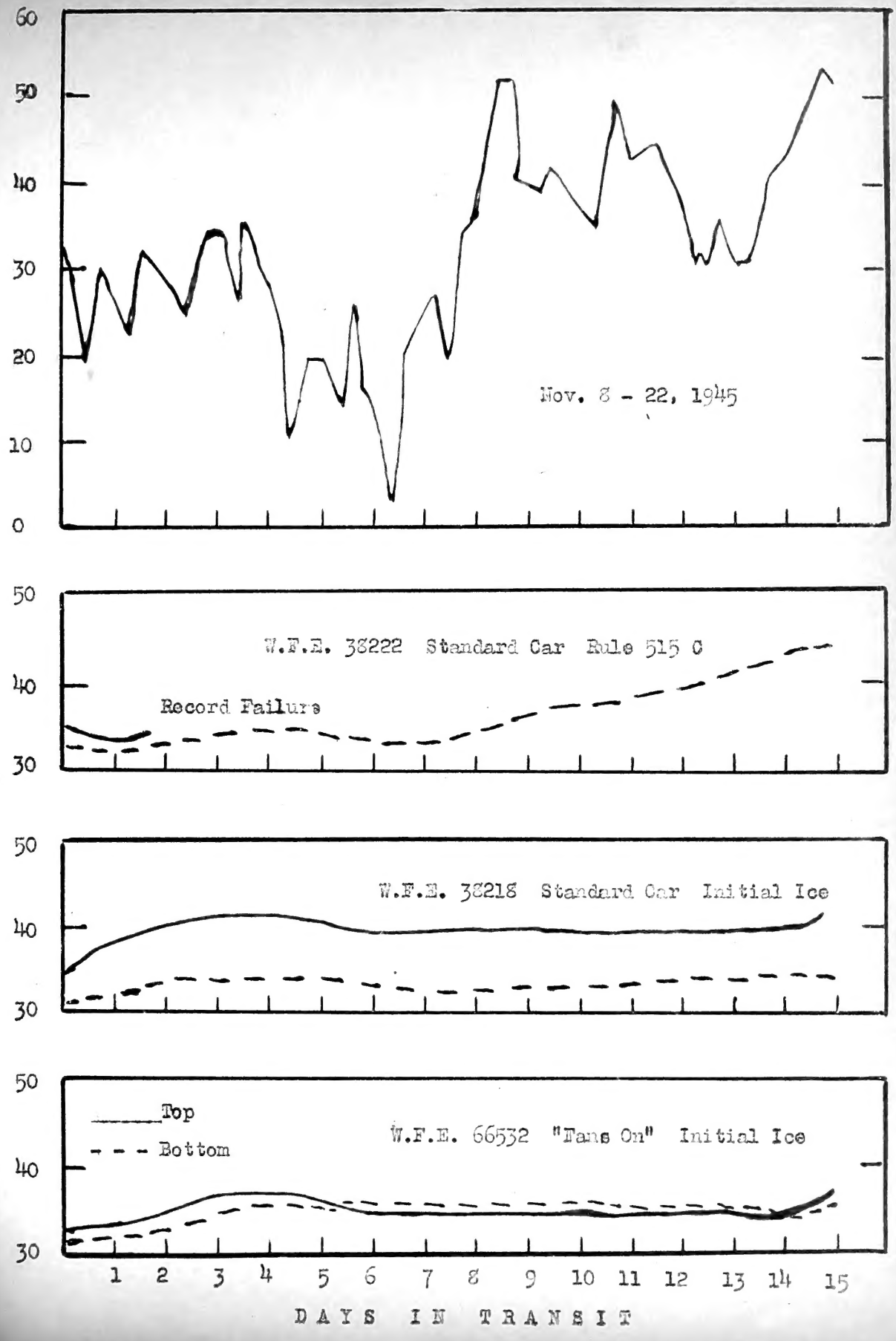

Figure 3 - Wenatchee - Houston and New York

Test 3